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State of North Dakota

GIS Validation Project

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1 Executive Summary

As stated in the Statement of Work provided by the state of North Dakota, the goal of this report *"to produce an updated total estimate of one-time cost and annual maintenance costs to develop and maintain a statewide, seamless road centerline dataset and optionally, point address locations, usable for 9-1-1 purposes, including but not limited to dispatch, geocoding, and future automated vehicle location."*

Background

In November of 2006, the North Dakota GIS Technical Committee (GISTC) contracted with GeoComm to conduct a study to determine the most feasible and cost-effective approach for developing and maintaining a statewide road centerline dataset. The planned primary use for the data is for public safety applications

The report delivered in April 2007 provided draft centerline standards and two options for development of a statewide centerline. The recommended option estimated an investment of $1.8 million for a standards based street centerline. The recommended option called for the integration of existing data that meet the recommended standards and development of data that did not meet the recommended standards.

The ND 9-1-1 Association GIS Committee (formerly a sub-committee of the Wireless Committee) decided on March 13, 2008, that the findings in the April 2007 report should be validated and/or updated. They also decided to validate the spatial and attribute values reported by the jurisdictions during the initial study. In addition, the GISTC wanted to include the estimated development costs for a statewide address point file.

The validated and/or adjusted cost estimates will serve as the basis for the planned budget request. To quote the statement of work provided by the state of North Dakota, *"It is thus imperative that the estimated total cost to develop and maintain this statewide road centerline dataset (and optionally, point addresses) be as accurate as possible to ensure adequate funding to complete the project."*

Validation Results

Three components were covered in the validation process:

- Spatial accuracy
- Attribute accuracy
- Road mile estimate

Spatial Accuracy

The spatial accuracy for the statewide data set is under discussion. The state is currently looking at a spatial accuracy of one meter or less. According to the 2007 report and final review there are 11 counties that fall within the one meter or less spatial accuracy category. To test spatial accuracy, three counties were tested to see if they met the reported accuracy standards. The sample counties were Bottineau, Golden Valley, and McLean, as stated in the Scope of Work. GeoComm reclassified the three sample counties as "B" requiring spatial adjustment. The remaining "A" county classifications did not changes.

County	NSSDA Accuracy Level	Meet Draft Standard
Bottineau	8.2385 Meters	No
Golden Valley	8.4144 Meters	No
McLean	3.23 Meters	No

The three counties did not meet the draft accuracy standards and were reclassified for the project cost estimates. Due to cost and time issues a quarter of the required points for NSSDA calculations were tested in these three counties. Five test points per county were selected versus the recommended 20 points. The low number of points may have contributed to the variance in reported and tested accuracy in the three counties.

Attribute Accuracy

The purpose of attribute accuracy validation is to determine if existing centerline attributes follow acceptable standards for public safety. The attribute validation focused on the street name and address range fields. Sample address points were gathered in nine "A" or "B" counties. The point volume was based on two percent of the total households with a 75 point minimum.

County	Total Points	Address Visible	No Address	Number of Discrepancies	Percent of Sample Outside of Acceptable Variance
Billings*	105	35	70	34	97.14%
Burleigh	344	329	15	95	28.88%
Cass	635	424	211	174	41.04%
Grand	272	258	14	96	37.21%

County	Total Points	Address Visible	No Address	Number of Discrepancies	Percent of Sample Outside of Acceptable Variance
Forks					
Morton	283	247	36	49	19.84%
Pembina	116	74	42	13	17.57%
Ransom**					
Walsh	201	150	51	25	16.67%
Williams	163	124	39	31	25.00%

*Billings County data did not contain address ranges in an area where 25 points were collected.

** Ransom County did not provide data for the validation study. Seatol provided data for the 2007 report which did not contain address ranges. GeoComm collected sample data in Ransom County.

The percentages of addresses that fall outside of the acceptable variance are listed in the table above. The acceptable variance was based on a geocoded address falling within 1/10 of a mile (528 feet) of the actual address.

The street name attributes should be validated against public safety databases. An analysis report for these processes has been included in the price estimates for data development. This will ensure a full review will be completed on all data within public safety guidelines.

The centerlines in the county data were ranged to include all possible ranges within a mile or block of road. Therefore the discrepancies noted in the attribute validation are probably a function of miscalculation during the original address assignment process. Adjustment of the ranges to reflect actual resident addresses may account for the variance. An address point file would be required as the base resource for range adjustment.

Road Mile Validation

After reviewing several different options of validating the estimated road miles for the 53 counties in North Dakota, it was determined that the Census Bureau, TIGER 2006 2nd Edition dataset road miles, The estimated miles for the 16 counties that did not provide data was calculated by deducting 20 percent from the Census total after categories were removed. The estimated mileage by county is available in Appendix 1.

Estimated Miles	Miles
Using County data	36,127.9
Using Census data	66.284.8
TOTAL	**102,412.7**

Optional Development

Routing

Routing is becoming common place in most public safety mapping applications. Addition of routing attributes can be complex depending on the software being used or the application that is needed for a specific task. Price estimates listed in the development costs include attribute development to perform basic routing. The attributes include:

- One-way streets
- Streets to include in routing (coding of streets not viable for public safety response vehicles such as alleys, or trails)

Development of the routing attributes for "B" and "C" counties are included in the development costs. Additional costs are associated for "A" counties. It is assumed that all counties would require routing attribute development.

Optional Attribute Development	Cost Estimate
"A" Counties	$14,300
"B" Counties	Included in development
"C" Counties	Included in development
TOTAL	**$14,300**

Centerline Data Development

The estimates for the development of a state-wide centerline have been adjusted based on the validation project. Adjusted price estimates are affected by the following items:

- Adjustment to county classifications based on validation study and review of 2007 results.
- Adjusted road miles based on a hybrid of county miles where data was provided by the county and adjusted Census Bureau, TIGER 2006 2nd Edition. The adjustment included the removal of several

CFCC codes and a 20 percent decrease based on analysis described in the Road Mile Validation section of the report.

- Increase in estimated expenses due to gas, hotels, food, etc.
- Additional costs from 2007 report:
  - Analysis report for "A" and "B" counties
  - Increased fuel costs
  - Increase in general costs
  - Mileage adjustment for "B" and "C" counties ("A" counties not included in 2007 estimated costs)
  - Category adjustment based on validation study

Centerline Development	Time Estimate (Weeks)	Cost Estimate
"A" Counties	7	$16,945
"B" Counties	152	$502,538
"C" Counties	560	$1,698,159
TOTAL	719	**$2,217,642**

Centerline Data Maintenance

Centerline maintenance estimates are based on the ability of each county to provide acceptable data into the state centerline dataset. The state maintenance program is broken down into the following categories based on "A" counties already doing their own maintenance; "B" counties needing to upgrade or purchase of GPS equipment and "C" counties needing third party vendor support.

- "B" county GPS equipment estimates were $6,073. (Increased the budget to $6,500 to include tax, shipping, and possible price increases)
- Category "C" counties were broken down into three maintenance categories based on the county populations. Population estimates were derived from http://www.census.gov/2010census/ and are the 2007 population estimates.

Category	Number of Counties	Description	Detail	Estimated Costs
A	11	Maintenance procedure meets state standard	No enhancement to maintenance process. Current maintenance procedures meeting state standards.	$0

Category	Number of Counties	Description	Detail	Estimated Costs
B	10	Maintenance procedure does not meet state standard	Currently performing maintenance, spatial accuracy standard not currently met. Personnel available to support maintenance internally. Upgrade or provide GPS equipment to support North Dakota spatial accuracy standard.	$65,000
C	32	No maintenance procedure	No personnel to support data maintenance. Contract with third party vendor to support maintenance of centerline data. Bi-annual data update.	$234,410

Optional Point Development and Maintenance

The optional point file estimates are based on the following:

- Assumed all counties need development and maintenance
- Estimated point totals determined by dividing the unincorporated county population by 2.56 (people per household); data derived from 2007 population estimates from the census
- 68,162 - Estimated address points for rural North Dakota
- Collecting address points via GPS at the location where habitable, unincorporated structure's driveways intersect with the named road (GPS data collection would meet state accuracy standards)
- Attributing address points with addresses obtained in the field while collecting GPS points
  - attributes will be a mixture of those visible on the structure and those collected by surveying the resident where an address was not visible
  - if an address is not visible or the resident is not available or does not return a survey with a an address the point will remain without an address attribute
- Attributing address points with community names based on provided county resources

Optional Point File	Time Estimates (Weeks)	Cost Estimates
Development	324	$1,251,816
Maintenance	106	$370,940

Breakdown of costs by county can be found in Appendix 3.

Project Management

The project management estimates are broken down into two different phases. The first phase is for the development stage that ensures that deliverables meet the state standards as well as assist in finalizing other project components. The second phase of project management pertains to the ongoing validation and overseeing of the maintenance program.

Initial Development

The project management for Phase One, or data development stage, will be a one-time cost for a vendor to perform the following functions:

- Point of contact for project participants
- Development of RFP for data development/enhancement
- Assist in finalizing North Dakota data standards
- Assist in creating a list of qualified vendors

Project Management	Cost Estimate
State-wide Centerline Development Project	$90,120
Assist in RFP Development, list of approved vendors, finalize North Dakota data standards	Included

Maintenance

- Validate the data maintenance processes and deliverable to the state meets their standards
- Act as a general contractor for the maintenance project
- Ensure data quality in maintenance processes for 53 counties

Project Management	Cost Estimate
Statewide Centerline Maintenance Project - Annual	$56,180

Recommendations and Comments

1. Reclassify the three sample counties participating in the spatial validation project.
2. Deliver validation reports back to the county for review and possible adjustment:
    a. All discrepancies greater than the address per mile should be reviewed for possible adjustment in map data or addressing
    b. Range overlaps
    c. Odd/even addressing issues
    d. Odd/even ranging issues
3. Include a data synchronization analysis in the development costs.
4. Do not adjust the inclusive ranging in the existing county data.
5. Data development (C counties) should also be inclusive.
6. Address point development would be beneficial if funding is available and made in addition to the centerline data.
7. Estimated road mile process was based off of sound analysis processes. RFP language can be developed to protect the cost estimates for the state.
8. Third party project management will provide expertise in centerline development and maintenance for public safety while ensuring the quality of the product delivered by the vendor(s).

2 Data Validation

The report delivered to the North Dakota GIS Technical Committee (GISTC) in 2007 outlined data development procedures and associated cost estimates. Due to the project complexities and overall cost estimates, the committee felt validation of the survey findings would provide more accurate cost estimates. The 2007 report was based off information provided by counties in an online survey. Data analysis was completed on those datasets that were provided to GeoComm during the original project.

The validation process covers three main categories:

- Spatial Accuracy
- Attribute Accuracy
- Road Miles

Spatial Accuracy

The purpose of the spatial accuracy testing was to validate the accuracy levels reported in the 2007 surveys. The spatial accuracy level of the datasets plays an important role in determining the amount of work required for development of the statewide centerline.

The National Standard for Spatial Data Accuracy (NSSDA) was used to validate spatial accuracy of the centerline files. The NSSDA provides a method for estimating the positional accuracy of digital GIS data. The state contracted with Kadrmas, Lee, and Jackson (KLJ) to collect independent field reference data at sub-meter accuracy. Post processing on the sample data was completed by KLJ prior to delivery of coordinates to GeoComm. Test points were determined from digital line work provided by the counties. The corresponding field coordinates were then compared to the test locations to determine accuracy level of the county centerlines. NSSDA standards require 20 or more test points on each data set.

Due to cost and time to collect test points, the state determined that a total of five sample points in the test area was sufficient to test the accuracy of the centerline data. The criteria for county selection were based on the "A" classification as described in the 2007 report. The test counties also provided data for validation.

Bottineau, Golden Valley, and McLean Counties participated in the spatial accuracy validation. The table below shows the reported spatial accuracy levels from the 2003 and 2007 surveys.

County	2003 Survey	2007 Survey
Bottineau	Sub-Meter	1 Meter
Golden Valley	1-3 Meter	1 Meter*
McLean	Sub-Meter	Did not report accuracy

*During the validation process, Golden Valley stated the accuracy reported in the 2007 survey was incorrect. They should have responded with 1-3 meters.

Procedures for Determining Attribute Accuracy

The following bulleted list provides an overview of the procedures that were used in validating the accuracy of the centerline data for the three test counties:

- Selected three sample counties that were classified as an "A" (meet state accuracy standards) and agreed to provide data to the validation study.
- Obtained test data from counties.
- Converted projection of data to State Plane NAD 83 Feet (northern zone for McLean and Bottineau and southern zone for Golden Valley).
- Created a geodatabase with three different feature datasets for each county.
- GeoComm selected five intersection locations in each county. Asphalt intersections were preferred by KLJ.
- Imported the re-projected county shape file, test point locations, KLJ point data in corresponding feature datasets.
- Determine x, y coordinates from county test data and compare to x, y coordinates provided by KLJ for corresponding locations and add point IDs to corresponding points.
- Calculate accuracy statistic broken down by county (See Appendix 4):
  - Subtract x coordinate of test county point from x coordinate of KLJ coordinate (associated by ID)
  - Subtract y coordinate of test county point from y coordinate of KLJ coordinate (associated by ID)
  - Square the difference between test and KLJ coordinate
  - Calculate the (difference in x)^2 + (difference in y)^2 for each corresponding set of points broken down per county
  - Calculate by county:
    - Sum (difference in x)^2 + (difference in y)^2
    - Average = sum/number of points
    - RMSE = Root Mean Square (radial) of the average

- NSSDA = 1.7308 * RMSE

Note: Calculate worksheet broken down in the Positional Accuracy Handbook, October 1999. Available through LMIC. http://www.gis.state.mn.us/pubs.htm

Sample Point Review

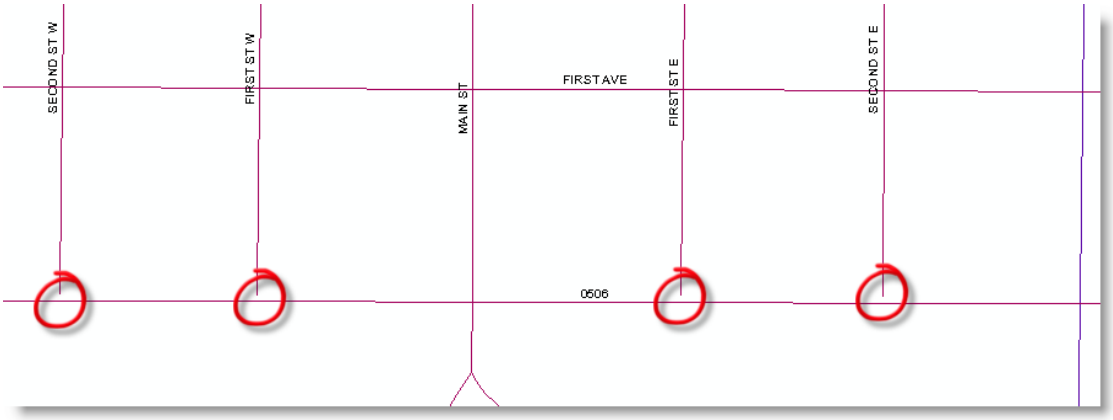
The following section provides a brief overview of point validation by county. Based on the sample test points, none of the centerlines meet the accuracy standard set by the state. The graphic display of sample point distribution can be found in Appendix 5.

McLean

- Initial point location for ID four could not be used due to street alignment in the county data. The intersection in the map data did not match the verified intersection location. Sample point location was moved to the intersection of a few miles to the north to the intersection of 4th St SW and 23rd Ave SW.

Bottineau County

- The point location for sample point ID8 was not a true intersection due to the spatial condition of the county data. Point location determined by approximate intersection location with a driveway. With point ID8 removed from the calculations the accuracy level for Bottineau County (4.3921) still falls outside of the state parameters being discussed.
- Bottineau County reclassified as a "C" based on attribute development and condition of the spatial data. The initial classification was based on spatial accuracy; however, when reviewing the data for the validation project it was noted that the centerline file did not contain address range attributes and segments are not broken or snapped at intersections.



Golden Valley

- During the validation project, the county reported to the state GIS Coordinator the accuracy noted in the 2007 survey was incorrect, and should be 1-3 meters.
- Reclassified as a "B."

Centerline Accuracy Results

County	NSSDA Accuracy Level	Meet State Standard
Bottineau	8.2385 Meters*	No
Golden Valley	8.4144 Meters	No
McLean	3.23 Meters	No

*Includes point ID8 values in calculation.

A spreadsheet showing calculation detail is located in Appendix 4.

The spatial validation test was meant to provide a general measure of calculated accuracy based on reported accuracy. According to the state standard being discussed, the three sample counties do not fall within the spatial accuracy standards. The process does not follow strict guidelines for spatial accuracy testing because of low volume and location determination of test points.

The low volume of test points could skew the results as the percentage of failed point locations is small. If one or two points exceed the acceptable level the reported accuracy for the county could be compromised.

Spatial Validation Recommendation/Observations

- NSSDA specific accuracy testing was cost and time prohibitive
- Three test counties did not pass spatial validation test based on minimal data collection. Reclassified according to scope of work and other findings
- All three counties use mapping grade GPS equipment for data development according to 2007 survey and reported meter to sub-meter accuracy
- Acceptance of reported accuracy may be cost beneficial
- Options if reported accuracy not accepted
  - Retest counties using specific NSSDA standards keeping in mind that testing can be expensive
  - Recreate spatial data for "A" counties at state accuracy levels and transfer attributes

Attribute Accuracy

The purpose of attribute accuracy validation is to determine if existing centerline attributes follow acceptable standards for public safety. The location of an address when geocoding an address using a centerline is determined by the address range attributes found on that centerline. The validation process focused on street name and address range attributes. It is important to understand that reported discrepancies could also be a function of how the address was originally assigned

Procedures for Determining Attribute Accuracy

GeoComm personnel used GPS to gather driveway locations in nine sample counties. Address attributes were gathered based on displayed address information. The number of sample points collected was determined by population in each county with a minimum number of points collected in the least populated counties.

The nine counties were selected for sample address point collection based on the following criteria:

- Centerline data availability
- "A" or "B" classification in 2007 report
- Participation in 2007 report

The number of sample point collected per county was determined by calculating two percent of all households in the county (Census data). A minimum of 75 points were to be taken in each county. The following table shows the projected address points to be taken in each county.

County	Classification	Point Count
Billings	B	75
Burleigh	B	244
Cass	B	449
Grand Forks	B	243
Morton	A	197
Pembina	A	75
Ransom	A	75
Walsh	A	100
Williams	A	120

Ransom County was classified an "A" county based on 2007 survey results. However the county could not locate attributed data for the validation study. GeoComm has reclassified Ransom County as a "C" for data development cost estimates.

The sample areas in each county were determined through random selection and available address information. Due to time and budget restrictions GeoComm did not contact residents to obtain or verify address information. Where possible the distribution of data collection was 60 percent rural, 20 percent cities, and 20 percent smaller towns.

The main factor to determine sample collection areas was locating address information posted on or near a residence. Address posting is an important factor in reducing the response time for public safety agencies. GeoComm exceeded the point collection in each county to ensure the appropriate volume of data for analysis. Sample data collection in some counties was more difficult than others; a high proportion of residences in Billings County did not have addresses posted.

The sample data collected as part of this project will be provided to the state as a project deliverable.

Address Sanity Check

The address sanity check process compares an address derived from centerline ranges to an actual assigned address. Software created by GeoComm calculates the best fit address for a point location based on centerline address ranges and the variance between the two addresses.

The software report provides variance and street name issues. Street name deviations may be misleading because resident confirmation was not within project scope. GeoComm reviewed the street name variance issues in the county report, and adjusted street name information in the points to match street name in the map data. Sample points close to intersections could be problematic without confirming the street name information.

Important Note: Street names in the map data must match the Master Street Address Guide (MSAG) to ensure data synchronization of public safety databases and high probability of call plotting. The estimated costs for data development listed in Appendix 1 include a Synchronization Analysis Report that will analyze the synchronization between the street names in the centerline and MSAG. The report results should be provided to "A" and "B" counties for review and adjustment.

Acceptable Variance

The sanity check calculated the difference between the assigned address and the best fit address based on address ranges. GeoComm calculated an acceptable variance between the two addresses. The variance was calculated using the county rural addressing scheme. The acceptable variance was calculated by taking 1/10 of the possible addresses per mile.

Acceptable variance = Possible addresses per mile 1/10

Eight counties have 100 addresses per mile or one address every 52.8 feet based on review of the map data provided by the counties. Burleigh County has 1,200 addresses per mile. Cass County appears to have 100 address per mile in the rural areas and average 1,200 addresses per mile in a buffer area around Fargo. The sample points around and within the city of Fargo were tested separately from the rural points. The areas with 1,200 addresses per mile scheme had an acceptable variance of 120 or less difference in the actual versus calculated address.

The formula accounts for a variance of 528 feet discrepancy from the sample point address from the geocoded address location. Geocoded addresses that exceed the 528 foot variance were considered a

discrepancy. The process quantifies the difference between determining an address location to a point versus a centerline file.

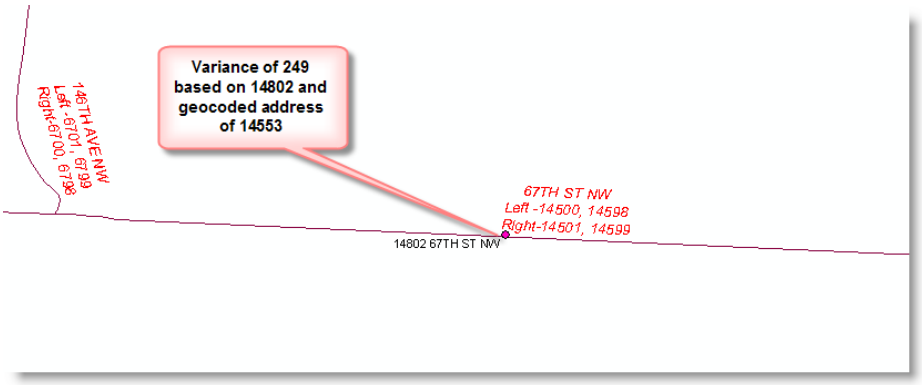
Results

County	Total Points	Address Visible	No Address	Number of Discrepancies	% of Sample Outside of Acceptable Variance
Billings*	105	35	70	34	97.14%
Burleigh	344	329	15	95	28.88%
Cass	635	424	211	174	41.04%
Grand Forks	272	258	14	96	37.21%
Morton	283	247	36	49	19.84%
Pembina	116	74	42	13	17.57%
Ransom**					
Walsh	201	150	51	25	16.67%
Williams	163	124	39	31	25.00%

*Billings County data did not contain address ranges in an area where 25 points were collected.

**GeoComm collected sample data in Ransom County. Ransom County did not provide data for the validation study. Seatol provided data for the 2007 report which did not contain address ranges.

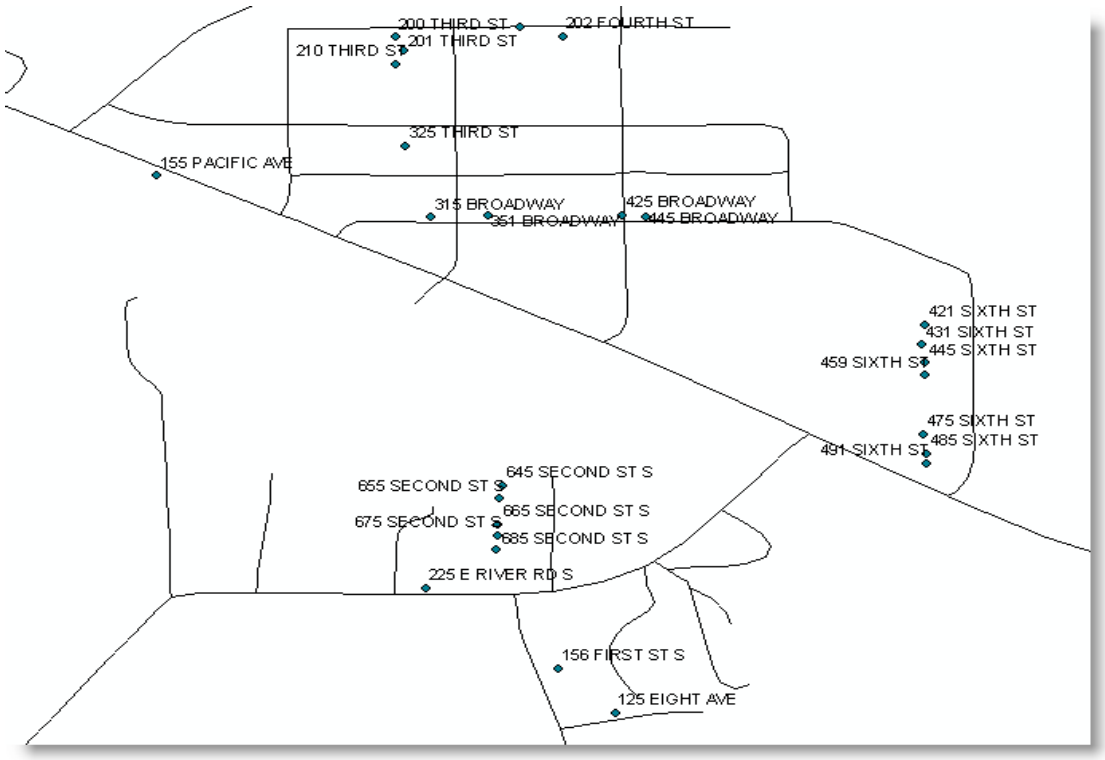
In the example below the address determined by the address ranges is 14553. The sample field work shows the assigned address on the point location is 14802. There is difference of 249 addresses between the assigned address and the geocoded address. If a call came into the dispatch center, the address location calculated by the centerline file would fall outside of the 528 foot acceptable variance. The higher the number in the sanity check report the farther away the geocoded location would be from the actual address location.



The ranging on most of the centerline information was inclusive. This means that each "block" or mile section is ranged to include all possible addresses in the block range. As example, the 1400 block would be ranged from 1400 to 1499. The variance in the geocoded locations becomes a function of how the addresses were originally assigned. Adjustment in the address ranges to actual ranges could provide a closer geocoded location.

Billings County Discrepancies

The high percentage of discrepancies in Billings is a result of address ranges missing in the areas where sample points were collected. It was extremely difficult for GeoComm to obtain the minimum number of sample points due to the lack of address posting in the county. In the example below, 75 percent of the points were located in a small community that did not have ranges or street names. Billings was classified as a "B" in the 2007 report. As a function of the validation study, Billings will be reclassified as a "C" county. Additional address ranges will be needed on the Billings County centerline data. The reclassification will ensure the costs estimates will cover the additional work that will be needed to ensure standards are met for public safety.



Address Range Standards

The geocoding process requires four address fields that reflect the low to high odd, and low to high even ranges on a street. Odd/even consistency and overlapping ranges are two primary discrepancies that affect geocoding results.

Odd/Even Consistency

Odd/even inconsistency is a discrepancy where there is a mixture of odd and even ranges on the same side of the road.

Attributes of Odd_Even_Issues

OID	OBJECTID	UID	LFROM	LTO	RFROM	RTO
40	3741	4011	16	99	17	98
7	965	1058	36	48	49	58
21	2301	2515	300	305	301	306
35	3560	3803	300	312	301	312
36	3561	3804	300	312	301	312
26	3095	3328	336	357	0	0
20	2101	2261	401	418	400	419
46	4416	4739	402	602	401	6010

Overlapping Ranges

Overlapping ranges occur when overlapping ranges are in the four address fields with the same street name. In the example below the range of 14101 to 14199 for 104th St NE is covered by three different segments. This discrepancy will cause geocoding issues.

OBJECTID *	FID	Street	Left_From	Left_To	Right_From	Right_To
3	3476	104TH ST NE	14101	14135	14100	14134
4	3477	104TH ST NE	14137	14199	14136	14198
5	3478	104TH ST NE	14101	14199	14100	14198
6	3466	105TH ST NE	13847	13899	13846	13898
7	419	105TH ST NE	12801	12899	12800	12914
8	418	105TH ST NE	12801	12899	12800	12914
9	3465	105TH ST NE	13801	13845	13800	13844
10	3464	105TH ST NE	13801	13899	13800	13898
11	3475	106TH ST NE	14301	14399	14300	14398

Note: A refining layer is usually used to account for addresses that can occur in different cities, such as 102 Main St. The overlap analysis did not have a refining map layer to account for these issues.

Results

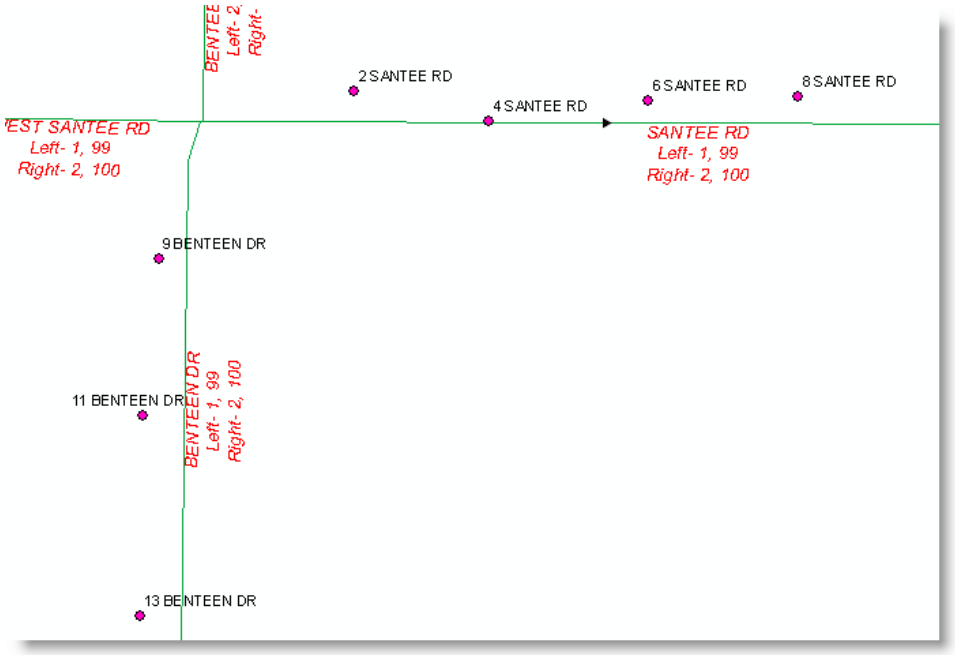
County	Segments in Centerline	Range Issues (odd/even)	Segments with Overlap
Burleigh	27395	18	879
Morton	4519	49	448
Cass	13581	39	970
Ransom			
Grand Forks	6398	59	1389
Walsh	4598	25	413
Pembina	3523	18	203
Billings	4005	4	36
Williams	5283	6	558

Range standards are reviewed in a data synchronization report. The estimated costs for data development listed in Appendix I include a Synchronization Analysis Report that will analyze the range standards. The report results should be provided to "A" and "B" counties for review and adjustment.

Odd/Even Address Discrepancy

During the analysis process GeoComm also looked for address discrepancies that may exist in the sample areas. The main address discrepancy noted in the address sanity check files was the possible odd/even addresses on the wrong side of the road. The possible address discrepancy is noted as "Odd/Even Issue" in the county sanity check files provided for each county.

In the following example diagram, Benteen Dr and Santee Rd have even addresses on the right side according to the address ranges. The field work shows the even addresses on the left side of the road. These discrepancies will affect the side of a road an address will geocode. The discrepancies are noted in the sanity check files and can be provided to the county for review.



The estimated costs for data development listed in Appendix 1 include a Synchronization Analysis Report that will analyze odd even discrepancies if an address point file is available. The report results should be provided to "A" and "B" counties for review and adjustment.

Attribute Validation Recommendation/Observations

- Reclassification of Ransom and Billings to "C" as a function of attribute issues observed during the validation process
- The majority of the attribute issues reviewed in the sanity check were a function of original address assignment.
- In areas where geocoded addresses exceeded the variance a combination of original address assignment and inclusive address range assignment (100-199, 200-299, etc.) could be affecting the results. The higher addresses per mile, the more forgiving the address assignment process. If you only have one address every 52.8 feet, which is the case in the majority of the state, small address variance is magnified.
- To achieve a closer geocoded location, actual address ranges would need to be applied to the centerline file (100-132, 200-87, etc.).
- Acceptable variance could be raised due to the distribution of addresses in the rural area.

- Actual versus inclusive address ranges are a function of the attribute standards adopted by the state. NENA recommendations call for valid address ranges. Actual versus inclusive are based on local standards. http://www.nena.org/pages/Content.asp?CID=76&CTID=5, Document 02-014.
- Address sample points that exceeded the acceptable variance (1/10 of a mile) should be reviewed by the local jurisdictions. Adjustments in house numbers or address ranges are a decision for the local jurisdiction.
- Sample points that exceed the ranges per mile (100) should be reviewed by the county for possible ranging or address assignment issues. If the variance is more than the address ranges, the geocoded location could be within a different block range.

Road Miles

The road mile estimates in the 2007 report were a combination of accessible county data and adjusted StreetWorks data. The estimated road miles were used to estimate project cost. The validation study also includes a review of the estimated road miles for all 53 counties. As a result of this study it was determined the estimation of road miles on a county by county basis is problematic due to the available street data and due to the classification of a particular set of roads. Minimum maintenance roads may not show up on certain datasets so they may skew the total road mile estimate.

A road network for public safety is not based on ownership or maintenance but is based on access. County, township, state/federal, city, and private roads are considered part of the transportation network for public safety. It was difficult to obtain road mile values that contain all the necessary criteria.

GeoComm reviewed several sources to determine the best approach for estimating the number of road miles in a county with the necessary criteria:

- Local county departments
- StreetWorks
- State Treasurer's Department
- DOT
- Census Bureau, TIGER 2006 2nd Edition

Local County Departments

GeoComm contacted ten test counties to verify the number of road miles. GeoComm contacted several departments in each county and found that each department have different criteria for determining road miles, and in many cases these departments did not have any available information on the number of road miles in their county. The county road department may have county road miles estimates but would have

to guess at the number of township roads. Typically city streets were not included in any of the road mile estimates. If road miles were provided the confidence in their accuracy was reported to be low.

StreetWorks

GeoComm's in-house reference data is StreetWorks. StreetWorks is a commercially available street centerline dataset. As part of road mile calculation, we reviewed field verified centerline data rom past projects in the Midwest where we estimated the number of road miles based on StreetWorks and then completed actual field data collection to determine the actual road miles For these similar projects, we determined that the actual road miles GPS'd averaged approximately 15 percent less than road miles calculated by StreetWorks. In addition to the review of comparable Midwestern counties, we compared road mile estimates in StreetWorks to the available North Dakota centerlines. It was determined that the available StreetWorks data was too old for use in estimating road miles.

State Treasurer

Through discussions with county departments it was determined the state treasurer's office maintains road mile information by county. This information was provided to the state treasurer's office from each county. GeoComm and the North Dakota State GIS Coordinator reviewed the data and determined the information used by the treasurer's office did not include all the criteria needed for public safety. Therefore the data was not used in the validation process.

Department of Transportation (DOT)

The DOT provided information pertaining to the total road miles in the state. This information was included in the "North Dakota Transportation Handbook," dated December 2006 from the NDDOT. The statewide values were not broken down by county. There did not appear to be county codes to break out the DOT digital data available from the North Dakota HUB. The state road miles totals as reported by the DOT in December 2006 were:

State Highway System	7,385 miles
County System	19,043 miles
Other Rural Roads	56,509 miles
City Streets	3,860 miles
Trails	19,827 miles
Total	**106,624 miles**

Census 2006, 2nd Edition

The final source reviewed was the Census Bureau TIGER data available from the North Dakota HUB. The Census data contained left and right county codes which allows for the review of each county dataset. It was determined that the Census data, was the most inclusive dataset for calculating mileage estimates. GeoComm compared several county Census data with the data provided by the individual counties to determine CFCC code criteria that would obtain the closest match. The Census data had segments not included in the county data. After reviewing the data extensively the code breakdown did not appear to follow any pattern when compared to the county datasets which did not allow for the accurate removal of the additional segments. GeoComm compared 11 different county data sets to the corresponding Census data. The county data averaged 20 percent less segments than the county Census data. It was determined that Census data would be used for counties that did not provide or have their own centerline data with a 20 percent less adjusted value to account for excess segments. Utilizing county data and Census Bureau TIGER 2006 data, the adjusted, estimated total road miles for the state is 102,412 miles. This value is within four percent of the DOT state calculations.

Procedures for Determining Road Mile Estimates

- GeoComm obtained Census Bureau, TIGER 2006 2nd Edition county road miles.
- After reviewing the census metadata it was determine that some CFCC codes did not fit public safety criteria. All A5, A 71, A72, A73, A75, and all P codes were queried out of the Census data. Query left and right county using county FIPS codes to break to individual county data.
- GeoComm calculated the road miles from Census for the following "A" counties that provided data during the 2007 Report or the validation project:
  - Billings
  - Bottineau
  - Burleigh
  - Dunn
  - Golden Valley
  - Morton
  - Pembina
  - Stark
  - Stutsman
  - Walsh
  - Williams
- Comparison of the Census data (less the CFCC codes listed above) to the road miles from the county's GIS centerline file. The county road miles averaged 20 percent less than the Census data.

- Estimated road miles for the counties were broken down into two different categories:
  - County GIS centerline road miles used where county provided valid centerline data – 16 counties.

County GIS Data used to calculate road miles	
Billings	Mercer
Bottineau	Morton
Bowman	Oliver
Burleigh	Pembina
Cass	Stark
Dunn	Stutsman
Golden Valley	Walsh
Grand Forks	Williams

  - Miles estimates for the remaining counties are based on Census Bureau, TIGER 2006 2nd Edition reduced by 20 percent.
- Road miles used to estimate development costs for statewide centerline (Appendix 1).

3 Statewide Centerline

The goal of this project is to determine the cost to build a statewide centerline file for use in multiple applications, including public safety. The 2007 report outlined several development options for a statewide centerline layer based on the data that was currently available and based on standards deemed acceptable by the state. The approach selected by the state is to development the centerline using existing county data that meets the state standards. The remaining county data will be enhanced or built to bring all county data up to state standards.

The 53 counties in North Dakota were assigned a category based on a survey conducted for the 2007 report. Counties that did not fill out a survey were assigned a category based on available resource information. Some resource information included 2003 survey results or data provided by Seatol.

Centerline classification from 2007 report:

Classification	Definition	Spatial Development	Attributes Development
A	Spatial and attribute data meet recommended standards	None	None
B	Spatial data do not meet recommended standards, attributes meet standard	Spatially adjust existing segments	None
C	No existing data or spatial and attribute data do not meet recommended standards	Create new centerline segments	Develop required attribute information from resources and data gathered in the field

Development

To verify the data development costs, GeoComm has reviewed information provided in the 2007 report and has completed additional data reviews and comparisons in order to validate and/or update the cost estimates

Verifying County Classifications

As part of this project, GeoComm reviewed the data classifications assigned to the counties in the 2007 report. Of specific interest were the following counties: Barnes, Mountrail, Richland, Bottineau, McLean, Slope, Ransom, Billings, and Golden Valley. These counties required additional data review to confirm their original classification. In some cases the classification was changed. A description of the review along with the changes that were made can be found below.

Barnes, Mountrail, and Richland Counties

Barnes, Mountrail, and Richland Counties did not return surveys for the 2007 report but were classified as "A" counties. GeoComm verified their classification pertaining to the presence of address ranges. According to available resources and verification of address attributes, these counties will remain in the "A" classification.

County	Spatial Accuracy	Address Range Attributes
Barnes	Sub-Meter in 2003 survey	Yes
Mountrail	Sub-Meter in 2003 survey	Yes
Richland	Sub-Meter in 2003 survey	Yes

Bottineau County

Bottineau County returned a survey for the 2007 report and was categorized an "A" based on their response. The county provided data as part of the spatial analysis validation. The centerline did not contain address ranges. It was noted in the response that they did not have address ranges. Further analysis during the validation process determined additional work was required on the spatial and attribute data (see Section 2 – Spatial Validation). Because of this, Bottineau County was re-classified as a "C" county.

McLean and Slope Counties

After further review of the 2007 surveys, it was confirmed that two counties were coded incorrectly in the 2007 report. McLean was reported as a "B" but should be reclassified as an "A." However, the spatial validation results determined that McLean should have a "B" classification. Slope was reported as a "B" but should be reclassified as a "C." The reclassifications have been adjusted.

Ransom County

Ransom was classified an "A" county based on 2007 survey results. However the county could not locate the attributed data for the validation report. GeoComm has reclassified Ransom County as a "C" for data development cost estimates.

Billings County

Billings was classified as a "B" in the 2007 report. As a function of the validation study, Billings was reclassified as a "C" county. Additional address ranges will be needed on the Billings County centerline data. The reclassification will ensure the costs estimates will cover the additional work that will be needed to ensure standards are met for public safety.

Golden Valley County

Officials at Golden Valley County stated during the validation project that the reported accuracy of 1 meter in the 2007 survey was incorrect. The correct accuracy should be 1-3 meters. Because of this, the classification for Golden Valley was changed to "B."

The updated classification breakdown for 53 counties in North Dakota is:

Category	Number of Counties
A	11
B	10
C	32

Additional Attribute Development

GeoComm has reviewed the development process for other items that may be required for use in public safety, as stated in part A, item 4 in the Scope of Work: *Other variables that GeoComm deems important to ensure an accurate as possible estimate to develop and maintain road centerlines which will be used for geocoding, routing, and other functions relating to 9-1-1, AVL, and Computer Aided Dispatch purposes.*

AVL

Data used for AVL does not require additional attribute development. Spatial accuracy of the GIS data is the main factor for AVL use in public safety. The recommended spatial accuracy for public safety AVL is 3 meters or less. The options discussed for the North Dakota spatial accuracy standard falls within an acceptable range for public safety.

CAD

Common CAD mapping applications require basic street name and address range attributes. Additional attributes may be required based on functionality within the different CAD systems. The data requirements then become software specific and would probably be handled by the county. The North Dakota standards under review cover the basic attribute requirements for CAD.

Routing

Developing centerline attributes for routing is largely dependent upon the software that will perform the routing function. Routing can run the gammit from basic to complex and is determined by the software application performing the routing function. Complex routing can involve development of very detailed attributes within the centerline file. The attributes required for basic routing functionality are:

- Routing – whether streets included in the centerline should or should not be included in the routing functionality. As example, trails or alleys may be included on the centerline but may not be included in routing because a pumper truck may not be able to travel down a small or underdeveloped road.
- One-way – classifications of streets as two-way or one-way traffic flow.
- Street hierarchy – coding the street hierarchy that could be used to determine general speed limits.

The cost estimates in Appendix 1 include the development of basic routing components. GeoComm assumed all counties required the development of the basic routing attributes.

Data Synchronization for Public Safety

Synchronization of the GIS data with the Master Street Address Guide (MSAG) and the ALI database is important when developing public safety data that will be used for call location and routing functions. Synchronization affects call location accuracy, as well as the probability of a 9-1-1 call plotting within a mapping application. As public safety moves to Next Generation 9-1-1 (NG9-1-1), where GIS will play an expanded role, a high level of synchronization between these databases is necessary. In fact, data

synchronization is now recommended by the National Emergency Numbering Association (NENA). GIS data will play a role beyond call plotting with NG9-1-1. For more information see: http://www.nena.org/

GeoComm has included synchronization analysis that corresponds to the county classifications. County classification analysis breakdown is:

- A – Analysis report to determine the level of synchronization for public safety and basic routing attributes. Report provided to county.
- B – Development of spatial data that meets state accuracy standards with county attributes conflated to new line work. Analysis report is included in pricing and basic routing attributes.
- C – Development of spatial data that meets state accuracy standards and attributes that is synchronized for public safety. Also included is the development of basic routing attributes.

Maintenance

The first step to a successful maintenance program is to ensure that each county has the capability to provide data for the state system that meets the North Dakota Road Centerline Standard. New centerline developed for the "B" and "C" counties should be developed using GPS equipment meeting state accuracy standard. Centerline maintenance should follow the same standards. New roads should be collected using GPS' or digitized if using resources that meet the state accuracy standards.

County Maintenance Categories

The maintenance categories are based on the same breakdown for development. Counties require different levels of assistance to meet the state standards for maintenance. Below is a breakdown of the maintenance categories:

Category	Description	Detail
A	Maintenance procedure meets state standard	No enhancement to maintenance process. Current maintenance procedures meeting state standards.
B	Maintenance procedure does not meet state standard	Currently performing maintenance, spatial accuracy standard not currently met. Personnel available to support maintenance internally. Upgrade or provide GPS equipment to support North Dakota spatial accuracy standard.
C	No maintenance procedure	No personnel to support data maintenance.

Category	Description	Detail
		Contract with third party vendor to support maintenance of centerline data. Bi-annual data update.

"A" County

Current maintenance practices for "A" counties meet state of North Dakota standards. No adjustment to maintenance process is required. The development cost estimates include an analysis report for Data Synchronization. "A" counties will be responsible review of reported data discrepancies and adjustments to their data as appropriate.

"B" County

Current maintenance practices meet state standard for attributes but not spatial accuracy standards. The counties will be provided GPS equipment, software, and training to allow centerline development to meet state standards. The development cost estimates include an analysis report for data synchronization. These counties will be responsible for review of reported data discrepancies and adjustments to their data as appropriate.

GPS Equipment

It is assumed that the "B" counties have sufficient personnel to handle GIS data maintenance. Their current program does not accommodate the North Dakota Spatial Accuracy Standards currently being discussed. The ten "B" counties require an upgrade or purchase of GPS hardware and software capable of providing the required accuracy levels.

Recommended hardware/software:

Category	Item	Unit Cost
GPS Unit	Trimble Geo XH 2008 Standalone System (Sub-Foot Capable)	$5,125
Software	ArcPad (1 copy)	$396
Additional Items	External Patch Antenna (5m)	$67
	GeoExplorer 2008 Series Power/Serial Clip	$85

Category	Item	Unit Cost
Training	Minimum of 4 hours at $100 per hour	$400
	TOTAL	**$6, 073**

Note: Pricing does not include freight charges. Pricing was provided by Wes Schnieder, Frontier Precision, St. Cloud, Minnesota, May 2008. http://www.frontierprecision.com

"C" County

Centerline data does not meet attribute or spatial accuracy in the state of North Dakota standard. No maintenance program is currently established and no personnel are available for support. The best solution for the "C" counties is to contract with an outside vendor to maintain the GIS data to meet state standards. The county would communicate new roads and/or addresses to the vendor. The vendor will perform field work and make updates to the map data for the county. The vendor will be responsible for updating attributes information to meet the state standards. This process provides the least amount of impact on the counties while providing acceptable data into the state database.

4 Statewide Rural Address Point Database

Address point data can be used for geocoding in place of a centerline. GeoComm has a number of public safety clients that utilize an address point file in the dispatch mapping application. However, it is recommended that a centerline file be used in conjunction with the address point file in a dispatch center.

One advantage of an address point database is location accuracy in a rural setting. Geocoding within a city can provide emergency responders a location within a specific block. Rural areas where there are larger distances between addresses, a point database can provide a responder an accurate location versus a calculated location based on a centerline. Development and maintenance of an address point file comes with advantages and disadvantages. These will be discussed in the Risk and Mitigation portion of this section.

Address Point Development

Address point data does exist for some areas in the state, however since it was not a component of the 2007 report, the usability and coverage is unknown. Specific assumptions were made to provide cost and time estimates for the development of an address point database.

Assumptions

- Data development was calculated for all counties in North Dakota
- Attribute development would be limited to address information including house number, street name, and community name based on public safety criteria
- Resident information such as name, telephone number, etc., is not part of the project
- Attribute development will require knocking on doors to determine the accurate house number and street name of the structure. This process will increase cost and time estimates

Development Strategy

- Development of spatial and attribute information
- Point location at driveway access, recommended as the most cost effective approach for public safety
- Utilize GPS Equipment with post processing to provide sub-meter accuracy (draft standard)
- Survey resident – to determine address attributes; information will be gathered by address display if available

- Centerline collected at the same time. However due to the nature of attribute development the cost savings would be minimal
- Quality Control/Quality Assurance
  - Review for odd/even issues
  - Data synchronization with public safety databases
  - Standardized street names

Maintenance

- New address locations will be GPS'd
- Counties maintaining their own data would need to build address point collection into maintenance processes
- "B" counties will be provided GPS equipment for centerline maintenance. Same equipment could be used for address point maintenance
- "C" counties will have additional maintenance costs
- Additional quality control and assurance processes

Risk and Mitigation

If a point file is used for public safety there are some items to consider:

- Centerline backup
- GPS address location versus calculated address location
- Higher maintenance level
  - Address locate
  - Point reference

Centerline Backup

An address point layer is an extremely valuable data layer as it provides additional location information in a dispatch environment and can provide an accurate location for emergency responders when dispatching in rural areas. Developing or building point datasets have high costs due to attribute development. To assist in reducing the costs of building a point layer, point data can be collected at the same time as the data collection for centerline development. Typical datasets for public safety will have an address point layer in addition to the centerline. It is recommended the point file be developed in addition to a centerline file but not in place of it. A centerline layer is still required for routing and AVL applications.

Wireless Phase II 9-1-1 calls provide the dispatch center with latitude/longitude coordinates of a caller location. Typically, software functionality derives an address from an x, y based on the centerline attributes, not address points. Dispatchers prefer to dispatch to an address versus an x, y coordinate.

GPS Address Location versus Calculated Address Location

An address located with a point file is more accurate than using a centerline. If an address point file is created at sub-meter accuracy, the location of the address on a map will be sub-meter. The geocoded address location using a centerline is mathematically determined and the accuracy is a function of the address ranges.

Higher Level of Maintenance

If an address point file is used as the primary layer for address location in a dispatch center, a higher level of maintenance is required. The street centerline requires updating when a new street is added into a jurisdiction. This is not the case with a point file. As new houses or structures are added, new points will need to be added to the address point data layer. With a centerline, the new addresses are almost always covered with the original addition of the street segment to the centerline layer.

Address Locate

With a point file, any new structure that receives an address will require a new point. As an example, when a new house is built on an existing street, the centerline does not need to be updated if the new addresses are assigned within existing ranges, all calls would plot.

However with an address point layer, a new address requires a new point. The dispatch center will also require an updated layer more frequently then the centerline. Theoretically a new resident would have address information displayed on a 9-1-1 call within 24 hours of telephone installation. If the point file does not follow the same update schedule, a call could be answered in dispatch with no associated location in the map data. This shows the importance of having a centerline backup file.

Point Reference

Placing a point file in a dispatch mapping application provide dispatchers additional information to process 9-1-1 calls. As discussed in the above section, a point file brings a higher level of maintenance. The maintenance frequency can have a direct affect how a dispatcher handles an emergency. Typically a dispatcher will use the point file as a reference for dispatching emergency responders. As an example, a dispatcher may provide reference information such as "third house down on the left." Is that address still

the third house down on the left or have two more houses been built since the center received their last map update?

5 Project Management

Project management is an important part of any project whether it is the size of this statewide project or as small as a small single county data development project. There are two main projects described in this report, Data Development and Data Maintenance. Each of these projects will require a project manager to oversee that the data is being developed in the manner required by the state and that it is being maintained to the state's standards after the initial development phase. Project management for this centerline project is broken down into two sections. The first section covers project management for development stages of the statewide centerline. The second section outlines project management during the maintenance phase of the project.

Development Phase

Project management for the development phase of the state-wide centerline will cover the following items as stated in Item 1 C, Project Deliverables, in the Scope of Work for the North Dakota Road Centerline Validation Project:

- One point of contact for the state and multiple jurisdictions and vendors working for the counties or the state. The individual counties or the state will be able to select their vendor of choice for development or upgrading road centerlines. The state will pay the vendors doing the centerline work after the project manager vendor has ensured compliance with the North Dakota Road Centerline Standard.
- Development of RFP templates to be used by counties or the state for developing or upgrading their road centerlines. These templates will utilize the North Dakota Road Centerline Standard.
- Assistance in the finalization and adoption of the North Dakota Road Centerline Standard through participation in meetings held with local and state government and interested vendors. Note that this approach has already been taken by the North Dakota Association of Counties with regard to parcel development.
- Assistance by creating a list of pre-qualified vendors who will be developing or upgrading road centerline data and have agreed to abide by the North Dakota Road Centerlines. Note that this approach has already been taken by the North Dakota Association of Counties with regard to parcel development.

The state should expect these additional items for project management during the development stage:

- Monthly status reports
- Project Website/Portal site
- On-site meetings (we assumed eight on-site meetings) to assist in finalizing state standards, RFP development, finalizing list of pre-qualified vendors, status meetings, and presentations as necessary
- Conference calls as necessary

Cost estimates for the data development phase of the proposed project is located in Section 6 of this report.

Ongoing Project Maintenance

Project management for the maintenance phase of the project is discussed in Section 1, B, iii, in the Project Deliverable section of the Scope of Work for the North Dakota Road Centerline Validation Project. The components included in project management for the maintenance phase of the centerline project are:

- Project management and quality assurance to ensure efficient means of maintaining the currency, completeness, and accuracy of the statewide road centerline dataset.
- Quality assurance to ensure completeness and accuracy of the statewide road centerline dataset.
- General contractor that the state would utilize to ensure that all jurisdictions and the vendors used by the jurisdictions are following the North Dakota road centerline standards.

The state should expect these additional items for project management during the development stage:

- Project Website/Portal site
- On-site quarterly project status meetings and presentations as necessary
- Conference calls as necessary

Cost estimates for ongoing project management during the maintenance phase is located in Section 6 of this report.

6 Project Time and Cost Estimates

This section provides the full project cost broken down into development and maintenance for the statewide centerline and optional address point data project. Project management is also included for each category.

The development section calculates the time and cost estimated for the development of a centerline and rural address point database. Project management for the development stage estimates the third party vendor costs to oversee the development project and assist in finalizing other project components.

The maintenance section provides full project expense for maintenance of the statewide centerline. The maintenance component brings all North Dakota counties up to the same data standard through equipment purchase or provision of services. The maintenance costs also include project management that ensure the state spatial and attribute standards will be met on an ongoing basis.

The breakdown of county cost for development and maintenance are found in the following appendixes in this report.

- Appendix 1 – Development time and cost estimates by county
- Appendix 2 – Maintenance cost estimates by county
- Appendix 3 – Rural address point development and maintenance cost by county

"B" County Development

Development of "B" counties is based on the realignment of county centerline segments to GPS data. Processes would involve field work and movement of county data to the spatially accurate GPS data.

Another option for the development of the "B" county datasets involves a two step process. The first step would be the development of new line work based on GPS data collected in the field. The second step would be the conflation of the existing attributes to the new line work. This process is more time consuming and costly than the first process. If the state decided to use the conflation process the estimated costs would increase approximately $250,000.

The advantage of the conflation process is control of line work development. The synchronization for public safety would be completed during the development stage by the vendor. The current estimated costs include an analysis report that will provide synchronization errors to the county for resolution.

Development		
Component	**Time Estimate (hr)**	**Cost Estimate**
Analysis Report for synchronization only ("A" counties)	259	$16,945
Routing "A" counties		$14,300
Spatial realignment of county centerline to GPS and Routing ("B" counties)	6097	$502,538
Full development and Routing ("C" counties)	22,387	$1,698,159
Centerline Development		**$2,231,942**
Project management – state level	N/A	$90, 120
Optional Address points (all counties)	28,742	$1,251,814
		Average $23,620 per county
Maintenance		
Component	**Number of Counties**	**Cost Estimates**
**Maintenance program meets state standards (A) - Annual	11	$0
Maintenance program requires GPS equipment upgrade (B) – One Time $6,073 (hardware/software/training)	10	$65,000
No maintenance program requires third party (C) - Annual	32	$234,410
Project management – state level - Annual		$56,180
Address point maintenance - Annual		$370,940*
		Average $7,000 per county**
Estimated Project Totals		
Component	**Development**	**Maintenance (Annual)**
Centerline w/ Project Management	**$2,322,062**	**$290,590 (Add $65,000 first year – GPS)**
Optional Address Point File	**$1,251,814**	**$370,940***

*Price based on address point maintenance alone. Cost savings if done in conjunction with centerline maintenance. If centerline and point data collection at same time for could expect approximately 25 percent savings over the combined maintenance cost.

**Average calculated by total address point maintenance by 53 counties. Assuming all 53 counties will need point file development and maintenance.

Appendix 1

Centerline Development Breakdown

Category "A" Counties

Category "A" counties pricing includes:

- Completing an analysis to determine the level of synchronization among key components for 9-1-1 dispatch mapping
- Delivering a report including the results of the analysis
- Adding basic routing attributes for public safety

Category "B" Counties

Category "B" counties pricing includes:

- Developing road centerlines meeting the state spatial accuracy standards by GPS field collecting all MSAG-valid roads within the counties and adjusting county provided road centerlines to the GPS field collected data
- Completing an analysis to determine the level of synchronization among key components for 9-1-1 dispatch mapping
- Adding and attributing new road centerlines, as determined by field collection, with attributes as provided by the counties (this does not include any road centerlines that were pre-existing in the initial county provided road centerlines)
- Delivering a report including the results of the analysis
- Adding basic routing attributes for public safety

The county will be responsible for updating any road centerline attribute errors as depicted by the analysis report for segments which were attributed based on the old road centerlines as provided by the counties.

Category "C" Counties

Category "C" counties pricing includes:

- Developing road centerlines meeting the state spatial accuracy standards by field GPS collecting all MSAG-valid roads within the counties
- Attributing road centerlines with attributes based on resources provided by each county, such as the addressing scheme
- Adding basic routing attributes for public safety

Pricing Breakdown

	County	Category	Estimated Miles	Time Estimates *(in hours)*	Cost Estimate	Basic Routing
1	Adams	C	1099.2	504	$37,962	included
2	Barnes	A	2254.4	21	$1,375	$1,300.00
3	Benson	C	2046.4	875	$66,594	included
4	Billings*	C	1365	588	$44,247	included
5	Bottineau*	C	3144	1273	$97,076	included
6	Bowman*	B	2369	541	$44,291	included
7	Burke	C	1503.2	667	$50,534	included
8	Burleigh*	B	2214	619	$51,486	included
9	Cass*	B	4314	1095	$92,860	included
10	Cavalier	C	2150.4	973	$74,561	included
11	Dickey	C	1402.4	633	$47,969	included
12	Divide	C	2104	871	$66,103	included
13	Dunn*	A	1443	21	$1,375	$1,300.00
14	Eddy	C	972	458	$34,467	included
15	Emmons	C	2007.2	838	$63,552	included
16	Foster	C	846.4	427	$32,187	included
17	Golden Valley*	B	1419	409	$32,350	included
18	Grand Forks*	B	2764	725	$60,556	included
19	Grant	C	2208.8	921	$69,997	included
20	Griggs	C	1021.6	479	$36,044	included
21	Hettinger	C	1257.6	563	$42,473	included
22	Kidder	C	1935.2	816	$61,936	included
23	LaMoure	C	1697.6	745	$56,632	included
24	Logan	C	1032.8	481	$36,161	included
25	McHenry	C	3178.4	1294	$98,765	included
26	McIntosh	C	1330.4	599	$45,330	included
27	McKenzie	B	3747.2	800	$66,598	included
28	McLean	B	3519.2	787	$65,623	included

	County	Category	Estimated Miles	Time Estimates *(in hours)*	Cost Estimate	Basic Routing
29	Mercer*	B	1328	400	$31,918	included
30	Morton*	A	2098	27	$1,775	$1,300.00
31	Mountrail	A	2824.8	21	$1,375	$1,300.00
32	Nelson	C	1590.4	708	$53,792	included
33	Oliver*	B	836	288	$22,068	included
34	Pembina*	A	2221	21	$1,375	$1,300.00
35	Pierce	C	1868	773	$58,455	included
36	Ramsey	C	1594.4	727	$55,415	included
37	Ransom	C	1324.8	602	$45,612	included
38	Renville	C	1154.4	541	$40,914	included
39	Richland	A	2492.8	21	$1,375	$1,300.00
40	Rolette	C	1703.2	777	$59,274	included
41	Sargent	C	1444.8	646	$48,956	included
42	Sheridan	C	1228.8	547	$41,183	included
43	Sioux	C	1188	588	$44,774	included
44	Slope	C	1336	590	$44,511	included
45	Stark*	A	1832.9	27	$1,775	$1,300.00
46	Steele	C	964	468	$35,268	included
47	Stutsman*	A	2706	27	$1,775	$1,300.00
48	Towner	C	1356.8	617	$46,796	included
49	Traill	B	1476.8	433	$34,790	included
50	Walsh*	A	2639	21	$1,375	$1,300.00
51	Ward	A	3560.8	31	$1,995	$1,300.00
52	Wells	C	1861.6	798	$60,617	included
53	Williams*	A	3435	21	$1,375	$1,300.00
		TOTALS	**102,412.7**	**28743**	**$2,217,642**	**$14,300**

*County road miles used

Appendix 2

Road Centerline Maintenance Breakdown

Category "A" Counties

Category "A" counties will have maintenance completed by the county. Therefore no road centerline maintenance pricing has been estimated.

Category "B" Counties

Category "B" counties price estimates include the one-time maintenance cost for GPS equipment, software, and training. The estimated cost from vendor was $6,073. The estimated cost was increased to cover taxes, shipping, and possible price increases.

Category "C" Counties

Category "C" counties price estimates include the annual cost for a third party vendor to maintain the road centerline data. Category "C" counties were broken down into three maintenance categories based on the county populations. Population estimates were derived from http://www.census.gov/2010census/ and are the 2007 population estimates. The three maintenance categories include:

- 1 – Includes one day of on-site fieldwork two times per year (every six months) and routine in-house maintenance.
- 2 – Includes two days of on-site fieldwork two times per year (every six months) and routine in-house maintenance.
- 3 – Includes three days of on-site fieldwork two times per year (every six months) and routine in-house maintenance.

Maintenance price estimates include all travel and expenses for two on-site fieldwork visits per year.

If the category "C" counties contract for both address point maintenance and road centerline maintenance concurrently and fieldwork could be completed during the same on-site visits there would be an estimated reduction in maintenance costs.

Pricing Breakdown

	County	Category	Maintenance Category	Time Estimates	Cost Estimate
1	Adams	C	1	84	$7,030
2	Barnes	A		n/a	$0
3	Benson	C	2	104	$8,920
4	Billings	C	1	84	$7,030
5	Bottineau	C	1	84	$7,030
6	Bowman	B		n/a	$6,500
7	Burke	C	1	84	$7,030
8	Burleigh	B		n/a	$6,500
9	Cass	B		n/a	$6,500
10	Cavalier	C	1	84	$7,030
11	Dickey	C	1	84	$7,030
12	Divide	C	1	84	$7,030
13	Dunn	A		n/a	$0
14	Eddy	C	1	84	$7,030
15	Emmons	C	1	84	$7,030
16	Foster	C	1	84	$7,030
17	Golden Valley	B		n/a	$6,500
18	Grand Forks	B		n/a	$6,500
19	Grant	C	1	84	$7,030
20	Griggs	C	1	84	$7,030
21	Hettinger	C	1	84	$7,030
22	Kidder	C	1	84	$7,030
23	LaMoure	C	1	84	$7,030
24	Logan	C	1	84	$7,030
25	McHenry	C	1	84	$7,030
26	McIntosh	C	1	84	$7,030
27	McKenzie	B		n/a	$6,500
28	McLean	B		n/a	$6,500

	County	Category	Maintenance Category	Time Estimates	Cost Estimate
29	Mercer	B		n/a	$6,500
30	Morton	A		n/a	$0
31	Mountrail	A		n/a	$0
32	Nelson	C	1	84	$7,030
33	Oliver	B		n/a	$6,500
34	Pembina	A		n/a	$0
35	Pierce	C	1	84	$7,030
36	Ramsey	C	2	104	$8,920
37	Ransom	C	1	84	$7,030
38	Renville	C	1	84	$7,030
39	Richland	A		n/a	$0
40	Rolette	C	3	124	$10,810
41	Sargent	C	1	84	$7,030
42	Sheridan	C	1	84	$7,030
43	Sioux	C	2	104	$8,920
44	Slope	C	1	84	$7,030
45	Stark	A		n/a	$0
46	Steele	C	1	84	$7,030
47	Stutsman	A		n/a	$0
48	Towner	C	1	84	$7,030
49	Traill	B		n/a	$6,500
50	Walsh	A		n/a	$0
51	Ward	A		n/a	$0
52	Wells	C	1	84	$7,030
53	Williams	A		n/a	$0
		TOTALS		**2,788**	**$299,410**

Appendix 3

Address Point Breakdown

Address Point Development (all counties)

Address point development estimates are based on:

- Collecting address points via GPS at the location where habitable, unincorporated structure's driveways intersect with the named road (GPS data collection would meet state accuracy standards)
- Attributing address points with addresses obtained in the field while collecting GPS points
  - attributes will be a mixture of those visible on the structure and those collected by surveying the resident where an address was not visible
  - if an address is not visible or the resident is not available or does not return a survey with an address, the point will remain without an address attribute (field collection of GPS points is based on one fieldwork pass, if additional passes are desired to gather missing addresses, additional charges will apply)
- Attributing address points with community names based on provided county resources

The estimated costs are based on an estimated amount of points needing to be field collected. Point estimates for pricing were determined by dividing the unincorporated county population by 2.56 (people per household). Population estimates were derived from http://www.census.gov/2010census/ and were the 2007 population estimates.

Address Point Maintenance (all counties)

Pricing includes the annual cost for a third party vendor to maintain the address point data. Counties were broken down into three maintenance categories based on the county populations. Population estimates were derived from http://www.census.gov/2010census/ and are the 2007 population estimates. The three maintenance categories include:

- 1 – Includes one day of on-site fieldwork two times per year (every six months) and routine in-house maintenance.
- 2 – Includes two days of on-site fieldwork two times per year (every six months) and routine in-house maintenance.
- 3 – Includes three days of on-site fieldwork two times per year (every six months) and routine in-house maintenance.

Maintenance pricing includes all travel and expenses for two on-site fieldwork visits per year.

If category "C" counties contract for both address point maintenance and road centerline maintenance concurrently and fieldwork is completed during the same on-site visits there will be a reduction in maintenance costs.

Pricing Breakdown

	County	Estimated Rural Address Points	Maintenance Category	Development		Maintenance	
				Time	Cost	Time	Cost
1	Adams	349	1	74	$7,157	72	$6,250
2	Barnes	1167	1	226	$21,846	72	$6,250
3	Benson	2076	2	378	$36,472	92	$8,140
4	Billings	275	1	62	$5,957	72	$6,250
5	Bottineau	1155	1	224	$21,651	72	$6,250
6	Bowman	384	1	80	$7,722	72	$6,250
7	Burke	305	1	67	$6,453	72	$6,250
8	Burleigh	6115	3	1131	$109,127	112	$10,030
9	Cass	6871	3	1273	$122,836	112	$10,030
10	Cavalier	573	1	112	$10,763	72	$6,250
11	Dickey	725	1	137	$13,200	72	$6,250
12	Divide	319	1	69	$6,667	72	$6,250
13	Dunn	847	1	157	$15,167	72	$6,250
14	Eddy	323	1	70	$6,742	72	$6,250
15	Emmons	620	1	119	$11,517	72	$6,250
16	Foster	417	1	85	$8,243	72	$6,250
17	Golden Valley	216	1	52	$5,021	72	$6,250
18	Grand Forks	4691	3	878	$84,687	112	$10,030
19	Grant	524	1	103	$9,965	72	$6,250
20	Griggs	443	1	90	$8,671	72	$6,250
21	Hettinger	355	1	75	$7,251	72	$6,250
22	Kidder	460	1	93	$8,935	72	$6,250
23	LaMoure	752	1	141	$13,634	72	$6,250

	County	Estimated Rural Address Points	Maintenance Category	Development		Maintenance	
				Time	Cost	Time	Cost
24	Logan	309	1	68	$6,516	72	$6,250
25	McHenry	980	1	179	$17,309	72	$6,250
26	McIntosh	333	1	72	$6,899	72	$6,250
27	McKenzie	1834	2	338	$32,577	92	$8,140
28	McLean	1189	2	230	$22,210	92	$8,140
29	Mercer	700	1	133	$12,805	72	$6,250
30	Morton	2211	2	417	$40,186	92	$8,140
31	Mountrail	871	1	161	$15,550	72	$6,250
32	Nelson	429	1	87	$8,432	72	$6,250
33	Oliver	443	1	90	$8,664	72	$6,250
34	Pembina	954	1	191	$18,422	72	$6,250
35	Pierce	526	1	104	$9,996	72	$6,250
36	Ramsey	1456	2	275	$26,495	92	$8,140
37	Ransom	855	1	159	$15,293	72	$6,250
38	Renville	354	1	75	$7,226	72	$6,250
39	Richland	1859	2	358	$34,525	92	$8,140
40	Rolette	4311	3	799	$77,041	112	$10,030
41	Sargent	664	1	127	$12,220	72	$6,250
42	Sheridan	302	1	66	$6,390	72	$6,250
43	Sioux	1428	2	270	$26,049	92	$8,140
44	Slope	199	1	49	$4,738	72	$6,250
45	Stark	1864	2	359	$34,600	92	$8,140
46	Steele	392	1	81	$7,841	72	$6,250
47	Stutsman	1769	2	327	$31,534	92	$8,140
48	Towner	309	1	68	$6,516	72	$6,250
49	Traill	1118	1	218	$21,067	72	$6,250
50	Walsh	1345	2	256	$24,717	92	$8,140
51	Ward	6547	3	1219	$117,622	112	$10,030
52	Wells	635	1	122	$11,755	72	$6,250

	County	Estimated Rural Address Points	Maintenance Category	Development		Maintenance	
				Time	Cost	Time	Cost
53	Williams	2009	2	383	$36,937	92	$8,140
TOTALS		**68157**	**n/a**	**12,977**	**$1,251,816**	**4,236**	**$370,940**

Appendix 4

Spatial Validation Spreadsheet

The following spreadsheet displays individual calculation completed on five points collected for each of the three sample counties. The data is broken out by county and follows the NSSDA worksheet format.

POINT NUMBER	POINT DESCRIPTION	X (INDEPENDENT)	X(TEST)	DIFF IN X	(DIFF IN X)²	Y(INDEPENDENT)	Y(TEST)	DIFF IN Y	(DIFF IN Y)²	(DIFF IN X)² + (DIFF IN Y)²	
1	MCLEAN	1646781.191570000	1646789.381190000	-8.189620000	67.069875746	274962.421848000	274963.488447000	-1.066599000	1.137633427	68.207509172	
2	MCLEAN	1741616.295210000	1741618.825710000	-2.530500000	6.403430251	237222.459270000	237224.301130000	-1.841860000	3.392448260	9.795878510	
3	MCLEAN	1863119.903580000	1863122.731330000	-2.827750000	7.996170063	299104.183604000	299101.781378000	2.402226000	5.770689755	13.766859819	
4	MCLEAN	1835718.015300000	1835716.672290000	1.343010000	1.803675861	130651.382750000	130646.944403000	4.438347000	19.698924092	21.502599953	
5	MCLEAN	1895886.524070000	1895892.859030000	-6.334960000	40.131718200	62734.188497000	62728.362065100	5.826431900	33.947308685	74.079026886	
									SUM	**187.351874340**	
									AVERAGE	**37.470374868**	
									RMSE	**6.121304997**	
									NSSDA	**10.589857645**	Feet
										3.227788610	**Meters**
6	BOTTINEAU	1775530.048240000	1775535.048230000	-4.999990000	24.999900002	644168.731990000	644166.794986000	1.937004000	3.751984496	28.751884497	
7	BOTTINEAU	1955156.139120000	1955160.020680000	-3.881560000	15.066508035	711864.966348000	711857.429618000	7.536730000	56.802299092	71.868807126	
8	BOTTINEAU	1844321.602590000	1844325.430670000	-3.828080000	14.654196486	696297.837706000	696267.368935000	30.468771000	928.346006246	943.000202732	
9	BOTTINEAU	2017377.805360000	2017377.566520000	0.238840000	0.057044546	611286.606482000	611299.510655000	-12.904173000	166.517680814	166.574725360	
10	BOTTINEAU	1917434.831040000	1917436.575130000	-1.744090000	3.041849928	616788.147316000	616785.449815000	2.697501000	7.276511644	10.318361572	
									SUM	**1220.513981288**	
									AVERAGE	**244.102796258**	
									RMSE	**15.623789433**	
									NSSDA	**27.029155720**	Feet
										8.238486663	**Meters**
11	GOLDEN VALLEY	1092256.179620000	1092263.882030000	-7.702410000	59.327119807	476391.753321000	476384.897364000	6.855957000	47.004146387	106.331266193	
12	GOLDEN VALLEY	1094460.835970000	1094465.114500000	-4.278530000	18.305818961	407564.654755000	407552.749595000	11.905160000	141.732834626	160.038653587	
13	GOLDEN VALLEY	1134157.717530000	1134161.469820000	-3.752290000	14.079680244	474429.341235000	474430.611902000	-1.270667000	1.614594625	15.694274869	
14	GOLDEN VALLEY	1095873.987670000	1095902.447590000	-28.459920000	809.967046409	540600.684614000	540591.773215000	8.911399000	79.413032137	889.380078546	
15	GOLDEN VALLEY	1141806.465690000	1141805.099220000	1.366470000	1.867240261	405486.020789000	405476.026058000	9.994731000	99.894647762	101.761888023	
									SUM	**1273.206161218**	
									AVERAGE	**254.641232244**	
									RMSE	**15.957482015**	
									NSSDA	**27.606443885**	Feet
										8.414444096	**Meters**

KLJ SAMPLE DATA

OBJECTID	Point_Numb	Max_PDOP	Max_HDOP	Corr_Type	Rcvr_Type	GPS_Date	GPS_Time	Update_Sta
1	5	4.90000000000	2.00000000000	Postprocessed Carrier Float	GeoXH 2005	5/19/2008	04:30:23pm	New
4	3	2.00000000000	1.10000000000	Postprocessed Carrier Float	GeoXH 2005	5/19/2008	02:48:40pm	New
5	4	2.40000000000	1.70000000000	Postprocessed Carrier Float	GeoXH 2005	5/19/2008	03:39:13pm	New
3	2	1.70000000000	1.00000000000	Postprocessed Carrier Float	GeoXH 2005	5/19/2008	01:35:30pm	New
2	1	2.00000000000	1.20000000000	Postprocessed Carrier Float	GeoXH 2005	5/19/2008	12:27:24pm	New

SAMPLE POINT LOCATIONS

OBJECTID	ID	COUNTY	CROSS_ST1	CROSS_ST2	XCoor	YCoor
1	6	BOTTINEAU	US HWY 83 N	STATE HWY 256N	1775535.04823000000	644166.79498600000
4	7	BOTTINEAU	106TH ST NE	STATE HWY 43E	1955160.02068000000	711857.42961800000
2	8	BOTTINEAU	CO RD 6 NW	US HWY 83N	1844325.43067000000	696267.36893500000
5	9	BOTTINEAU	STATE HWY 60 N	CO RD 22	2017377.56652000000	611299.51065500000
3	10	BOTTINEAU	88 ST NE	STATE HWY 14N	1917436.57513000000	616785.44981500000

Feat_Name	Datafile	Unfilt_Pos	Filt_Pos	Data_Dicti	GPS_Week	GPS_Second	ID	XCoor	YCoor
Sample	R051915A.cor	140.00000000000	140.00000000000	ND ITD Centerline	1480	163837.00000000000	6	1775530.04824000000	644168.73199000000
Sample	R051913A.cor	100.00000000000	100.00000000000	ND ITD Centerline	1480	157734.00000000000	7	1955156.13912000000	711864.96634800000
Sample	R051914A.cor	100.00000000000	100.00000000000	ND ITD Centerline	1480	160767.00000000000	8	1844321.60259000000	696297.83770600000
Sample	R051912A.cor	85.00000000000	85.00000000000	ND ITD Centerline	1480	153344.00000000000	9	2017377.80536000000	611286.60648200000
Sample	R051911A.cor	100.00000000000	100.00000000000	ND ITD Centerline	1480	149258.00000000000	10	1917434.83104000000	616788.14731600000

KLJ SAMPLE POINTS

OBJECTID	Point_Numb	Max_PDOP	Max_HDOP	Corr_Type	Rcvr_Type	GPS_Date	GPS_Time	Update_Sta	Feat_Name	Datafile
3	1	1.60000000000	0.90000000000	Postprocessed Carrier Float	GeoXH 2005	5/17/2008	01:38:32pm	New	Sample	R051712A.cor
2	2	2.50000000000	1.20000000000	Postprocessed Carrier Float	GeoXH 2005	5/17/2008	12:04:20pm	New	Sample	R051711A.cor
4	3	2.30000000000	1.20000000000	Postprocessed Carrier Float	GeoXH 2005	5/17/2008	02:32:14pm	New	Sample	R051713A.cor
5	4	1.70000000000	0.90000000000	Postprocessed Carrier Float	GeoXH 2005	5/18/2008	01:42:04pm	New	Sample	R051812A.cor
1	5	2.00000000000	1.10000000000	Postprocessed Carrier Float	GeoXH 2005	5/18/2008	02:06:28pm	New	Sample	R051813A.cor

SAMPLE POINT LOCATIONS

OBJECTID	ID	COUNTY	CROSS_ST1	CROSS_ST2	XCoor	YCoor
3	1	MCLEAN	23 ST NW	57 AVE NW	1646789.38119000000	274963.48844700000
2	2	MCLEAN	16TH ST NW	2 ST SW	1741618.82571000000	237224.30113000000
1	3	MCLEAN	29 ST NW	16 AVE NW	1863122.73133000000	299101.78137800000
4	4	MCLEAN	8 ST SW	HWY 200A	1835716.67229000000	130646.94440300000
5	5	MCLEAN	HWY 41	14 AVE SW	1895892.85903000000	62728.36206510000

Unfilt_Pos	Filt_Pos	Data_Dicti	GPS_Week	GPS_Second	ID	XCorr	YCoor
50.00000000000	50.00000000000	ND ITD Centerline	1479	585526.00000000000	1	1646781.19157000000	274962.42184800000
36.00000000000	36.00000000000	ND ITD Centerline	1479	579874.00000000000	2	1741616.29521000000	237222.45927000000
54.00000000000	54.00000000000	ND ITD Centerline	1479	588748.00000000000	3	1863119.90358000000	299104.18360400000
60.00000000000	60.00000000000	ND ITD Centerline	1480	67338.00000000000	4	1835243.45244000000	110414.10724500000
100.00000000000	100.00000000000	ND ITD Centerline	1480	68802.00000000000	5	1895886.52407000000	62734.18849700000

KLJ SAMPLE DATA

OBJECTID	Point_Numb	Max_PDOP	Max_HDOP	Corr_Type	Rcvr_Type	GPS_Date	GPS_Time	Update_Sta	Feat_Name
4	4	2.30000000000	1.50000000000	Postprocessed Carrier Float	GeoXH 2005	5/20/2008	12:57:37pm	New	Sample
3	3	1.90000000000	1.10000000000	Postprocessed Carrier Float	GeoXH 2005	5/20/2008	12:16:23pm	New	Sample
2	1	1.60000000000	0.80000000000	Postprocessed Carrier Float	GeoXH 2005	5/20/2008	10:57:57am	New	Sample
5	5	1.90000000000	1.10000000000	Postprocessed Carrier Float	GeoXH 2005	5/20/2008	01:52:07pm	New	Sample
1	2	1.90000000000	1.10000000000	Postprocessed Carrier Float	GeoXH 2005	5/20/2008	02:56:06pm	New	Sample

SAMPLE POINT LOCATIONS

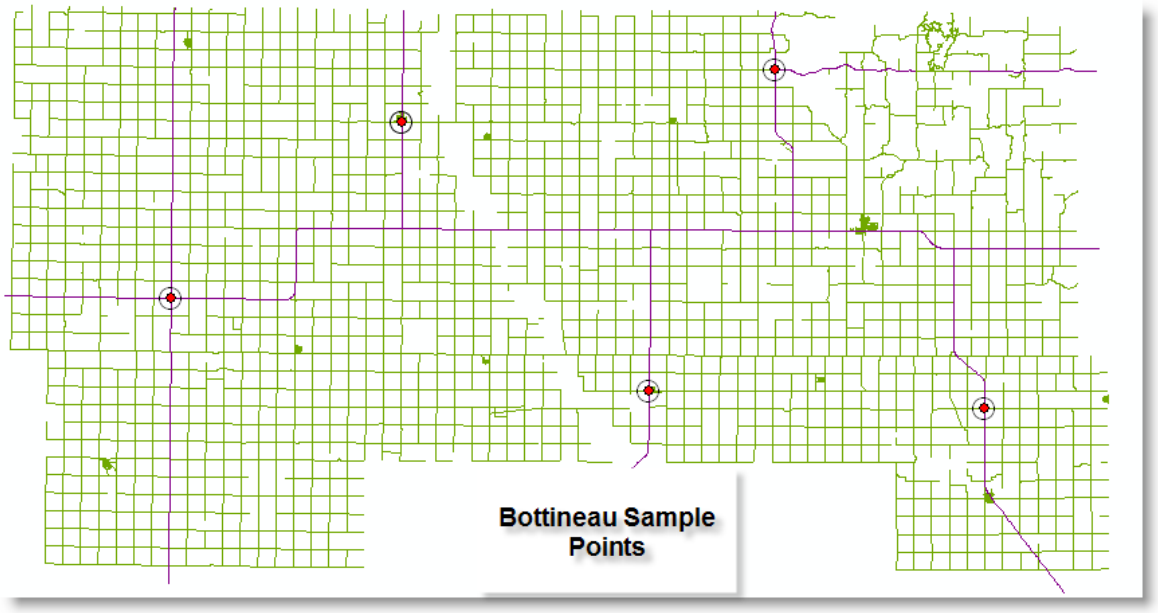
OBJECTID	ID	COUNTY	CROSS_ST1	CROSS_ST2	XCoor	YCoor
2	11	GOLDEN VALLEY	4TH ST NW - OLD HWY 10	HIGHWAY 16	1092263.88203000000	476384.89736400000
5	12	GOLDEN VALLEY	PIPELINE RD	HIGHWAY 16	1094465.11450000000	407552.74959500000
3	13	GOLDEN VALLEY	OLD HIGHWAY 10	COUNTY RD 11	1134161.46982000000	474430.61190200000
1	14	GOLDEN VALLEY	BONNIE VIEW RD	HIGHWAY 16	1095902.44759000000	540591.77321500000
6	15	GOLDEN VALLEY	PIPELINE RD	COUNTY RD 11	1141805.09922000000	405476.02605800000

Datafile	Unfilt_Pos	Filt_Pos	Data_Dicti	GPS_Week	GPS_Second	ID	XCoor	YCorr
R052011B.cor	116.00000000000	116.00000000000	R052013B	1480	237471.00000000000	11	1092256.17962000000	476391.75332100000
R052011A.cor	100.00000000000	100.00000000000	R052013B	1480	234997.00000000000	12	1094460.83597000000	407564.65475500000
R052009A.cor	100.00000000000	100.00000000000	R052013B	1480	230291.00000000000	13	1134157.71753000000	474429.34123500000
R052012A.cor	140.00000000000	140.00000000000	R052013B	1480	240741.00000000000	14	1095873.98767000000	540600.68461400000
R052013B_SPLIT.cor	100.00000000000	100.00000000000	R052013B	1480	244580.00000000000	15	1141806.46569000000	405486.02078900000

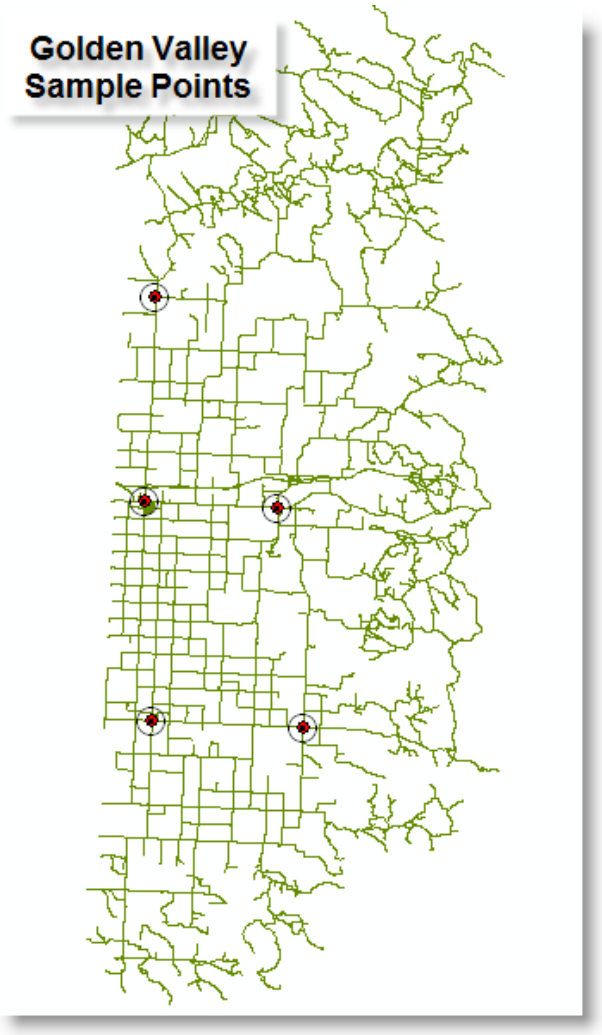
Appendix 5

Sample Point Locations

Bottineau County Sample Point Locations



Golden Valley County Sample Point Locations



McLean County Sample Point Locations